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[redacted]

[redacted]

GD GENERAL DYNAMICS

CONVAIR (ASTRONAUTICS) DIVISION
GENERAL DYNAMICS CORPORATION

[redacted]

[redacted]

AA 61-0173
November 1961

WS 107A-1 FLIGHT TEST WORKING GROUP

FLIGHT TEST REPORT

ATLAS MISSILE 32E

GENERAL DYNAMICS | ASTRONAUTICS

10 November 1961

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ERRATA

Flight Test Report 32E

Please remove page no. 24 of final copy, 32E Flight Test Report, AA 61-0173, dated 17 November 1961 and replace with the attached page. Conclusions and Recommendations were omitted.

H. C. O'Dell

H. C. O'Dell, Supervisor,
Data and Weights

THIS PAGE IS TO BE DECLASSIFIED WHEN ENCLOSURE IS DETACHED.

FOREWORD

This report has been prepared to present preliminary information relative to the flight of Atlas Missile No. 32E. The information presented is based on visual observation and data evaluation to the extent permitted by time limitations. It should be considered as preliminary only, and the final reports on this flight referenced for further information. The technical content has been prepared and jointly agreed upon by members of the WS 107A-1 Flight Test Working Group.

Prepared by: Data and Weights, General Dynamics/Astronautics, AMR

for E. V. Thatcher
Manager, WS 107A-1 Project Office
Space Technology Laboratories, Inc.
AMR, Florida

K. E. Newton
Chief of Test Operations, AMR
GD/Astronautics, A Division of
General Dynamics Corporation

for L. D. Solid
Responsible Representative
WS 107A-1
Rocketdyne, AMR, Florida

M. J. Swing
Manager, Field Test Engineering
General Electric (DSD)
AMR, Florida

for W. H. Caldwell
Manager, Test Operations
Burroughs Laboratories
Burroughs Corporation

for O. M. Henriksen
Test Operations Section Head
American Bosch ARMA Corp.

for C. W. Bailey
Flight Test Manager
General Electric - MSVD

T. F. Davidson
Site Manager, AMR
Acoustica Associates

for P. R. Wignall
Colonel, USAF
Commander

SUMMARY

Atlas Missile 32E, the 15th "E" Series missile to be flight tested from AMR and the 100th Atlas flight was launched from Complex 13 at 0955 EST on 10 November 1961. The flight was unsuccessful and the missile was destroyed by the Range Safety Officer at 35 seconds.

The flight was unsuccessful because of a premature shutdown of the sustainer engine immediately after liftoff. Preliminary investigation indicated shutdown occurred due to LO2 starvation of the gas generator during the transition period. Static tests conducted by Rocketdyne substantiated this and indicated LO2 starvation was due to improper LO2 regulator operation. The regulator malfunction resulted from incorrectly installing a pressure transducer on the test port of the regulator and hampering regulator response to the point of actually preventing the necessary LO2 flow to the gas generator.

Vernier engine ignition did not occur due to sustainer engine shutdown prior to expiration of the vernier ignition delay timer. Fire in the thrust section was evidenced starting at 19 seconds. After 21 seconds telemetry data became intermittent. Missile stability was maintained by the booster engines until approximately 24.5 seconds when the B2 Engine performance began to decay.

The AFSWC pod experienced difficulty during the countdown. At the time of Sequence II pressurization the holddown explosive bolts failed and the pod fell and wedged between the missile tank and Scientific Passenger Pod. The AFSWC Pod was removed and was not flown.

All other systems performed normally until affected by the failure at liftoff and the resulting abnormal missile behavior.

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FLIGHT TEST OBJECTIVES

The primary purposes of this flight were to obtain data for determining the performance of the Propellant Utilisation System and to evaluate the Inertial Guidance System performance.

Detailed objectives are listed on the following page along with applicable comments relative to the degree of satisfaction.

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
1.- First Order 2 - Second Order 3 - Third Order					
Weapon System					
1. Obtain data on repeatability of all airborne and ground systems.	2			X	
2. Evaluate ARMA Inertial Guidance System performance.	1		X		
3. Evaluate Flight Control System performance.	2		X		
4. Evaluate the performance of the Acoustica PU System.	1		X		
5. Obtain Data on lateral drift during liftoff.	2		X		
Non-weapon System					
1. Obtain data on AFSWC Pod experiment	2		X		
2. Determine re-entry vehicle dynamic pressure distribution, vehicle loadings and vehicle motions.	2		X		
3. Determine re-entry vehicle heat shield performance with emphasis on ablation materials and design.	2		X		
4. Obtain data on the special experiments incorporated in the re-entry vehicle.	3		X		
5. Obtain data on performance of separation and recovery system	3		X		

FLIGHT TRAJECTORY DATA

The flight of Atlas Missile 32E was planned for a range of 4388 nautical miles, with impact in the Ascension Island splash net. This range was not achieved as the flight was terminated approximately 35 seconds after liftoff when the missile became erratic and was destructed by Range Safety action.

The trajectory was considerably different from nominal due to sustainer engine shutdown at liftoff. The missile maintained stability until approximately 24.5 seconds when the B2 Engine shut down. Velocity and altitude at this time were 237 feet per second and 2700 feet compared to nominal values of 450 feet per second and 4986 feet. After 24.5 seconds missile maneuvers were erratic and destruction by the Range Safety Officer occurred at 35.404 seconds.

Note: All times in this report are referenced to Range Zero which occurred at 0955:36 EST. One Inch Motion occurred at 0955:36.43 EST.

SYSTEMS PERFORMANCE

AIRFRAME

Airframe structural integrity was satisfactorily maintained until at least 21.5 seconds when propellant tanks telemetry pressure data was lost. Review of the flight films indicates that structural integrity was maintained until Range Safety Command System destruction of the missile at 35.4 seconds.

The engine compartment was instrumented for environmental temperatures with Measurements A 638 T, Aft Side A Frame Quadrant 2, and P 671 T, Thrust Section Ambient Quadrant 4. Both measurements indicated normal temperatures of 94°F from liftoff to 19 seconds. The presence of a fire after this time in the engine compartment was indicated when both measurements rose above 300°F by 21.7 seconds.

Missile 32E carried special instrumentation to implement a study of fuel tank skin heating due to disturbance of aerodynamic flow caused by the Scientific Passenger Pod. These temperature measurements were active during flight from an instrumentation standpoint, but had indicated no temperature increase prior to missile destruction.

For support of the study of temperature environment during staging a low mass thermistor was located near each LO2 staging disconnect. Also a pressure measurement was located at each of these points. The thermistors indicated little temperature change until approximately 18 seconds. At this time the measurements began to fluctuate. The ambient pressure measurements remained above 100 per cent (greater than 6 psia) until telemetry data became intermittent.

Five temperature measurements were added in the V2 fairing area to study environmental conditions during flight. These measurements did not activate until after 20 seconds and activation after this time reflected the fire on the missile.

Three accelerometers were placed in the thrust section for staging studies. The measurement monitoring booster thrust section longitudinal acceleration remained at 25 per cent until 22 seconds and then rose to the upper band and became erratic. Data from this measurement appeared invalid throughout flight. The two accelerometers mounted on the jettison rails appeared to provide valid data.

PROPULSION SYSTEM

Sustainer engine operation was unsatisfactory. A failure in the sustainer engine system caused shutdown during the start phase of operation. Due to a thrust section fire starting at 19 seconds and subsequent loss of missile control due to B2 Engine shutdown at approximately 25 seconds the missile was destroyed by the Range Safety Officer at 35 seconds.

Booster engine operation appeared normal during the start phase. Steady state chamber pressures and pump speeds were 575 psia and 6110 rpm for B1 and 585 psia and 6100 rpm for B2. Booster engine parameters indicated normal engine operation until approximately 22 seconds when telemetry RF No. 1 pressure data was lost. Film coverage and booster gas generator temperatures recorded on telemetry RF No. 3 indicated the B1 Engine continued to operate until missile destruction. A sharp rise in B2 GG temperature recorded on telemetry at 25 seconds indicated B2 Engine performance began to decay at that time. At 9 seconds a variation in B2 performance was noted when the chamber pressure decayed from 590 psia to 575 psia before stabilizing at 585 psia. During the same period B2 Pump speed decayed from 6155 to 6020 rpm and then stabilized at 6100 rpm.

Telemetered sustainer engine data exhibited the following characteristics during the start phase of operation.

The LO2 Regulator Outlet Pressure, measured inflight for the first time appeared to indicate abnormal conditions. This was indicated by comparison with captive test data. The pressure rose sharply to a 1000 psig peak at 0.75 seconds and then decayed gradually to zero(relative to decay of other parameters). This measurement did not indicate the normal LO2 pump discharge pressure transient immediately following ignition of the solid propellant gas generator.

All other sustainer engine pressure measurements indicated a normal start until between 0.68 and 0.72 seconds. At this time engine performance started to decay abruptly. During the decay period, at approximately 50 per cent of the peak pressures, a short duration, low magnitude transient rise occurred. This rising transient occurred on the pressures between 0.26 and 0.36 seconds after the pressures peaked. After the transient rise the pressures decayed at varying rates to zero.

Measurement P 531 O, Sustainer Gas Generator Check Valve Vibration, which was measured in flight for the first time, showed significant response at -0.338 seconds. At this time a shock load was indicated that drove the signal out of band. Apparently the accelerometer amplifier was overdriven causing an invalid output until the system was unsaturated at -0.07 seconds. The excitation appeared local to the gas generator unit since no similar response was observed on the engine displacement measurements or missile tank regulator vibration measurements. The response is apparently indicative of a high frequency condition. Between -0.07 seconds and +2.4 seconds the over-all level was approximately 6 G's RMS.

Preliminary investigation indicated LO2 starvation of the gas generator during the transition period. Gas generator combustor temperature indicated fuel rich shutdown. The sustainer LO2 regulator appeared to be the source of LO2 starvation. Static firing tests were conducted by Rocketdyne on an engine with the same LO2 regulator outlet instrumentation as that on 32E. Results of these tests indicated that the cause of the engine failure was gas generator LO2 starvation during transition due to improper LO2 regulator operation. The regulator malfunction resulted from incorrectly installing a pressure transducer on the test port of the regulator and hampering regulator response to the point of actually preventing the necessary LO2 flow to the GG.

Several items of sustainer hardware were recovered for inspection. Major items included the fuel tank apex with sustainer LO2 dome attached, sustainer hydraulic pump, sustainer low pressure LO2 duct, sustainer LO2 and fuel turbo pumps, sustainer engine throat section, sustainer main LO2 and fuel valves, sustainer engine exhaust section, the sustainer LO2 reference regulator, and hydraulic control manifold.

PROPELLANT UTILIZATION

Operation of the Acoustica Propellant Utilization(PU) System was satisfactory. Premature termination of the flight precluded uncovering of sensors except at Station 1. Sensor uncovering at Station 1 indicated a 2.02 second fuel first error. Uncovery of fuel and LO2 sensors occurred at 8.27 and 10.29 seconds, respectively. The system generated the correct signal to position the PU valve; however, there was no valve response because of sustainer engine failure and subsequent shutdown during the start phase.

System values for this flight were as follows:

LO2 Stillwell	Model No. SL-192 ("F" Series)	
Fuel Stillwell	Model No. SF-191 ("F" Series)	
Computer	Model No. CA-108B - Serial No. 0084	
PU Valve Position	Nominal	28.5°
	± 15 Per cent	22°
	- 15 Per cent	48.2°

PNEUMATIC SYSTEM

Performance of the Pneumatic System was satisfactory until at least 21.5 seconds as indicated by telemetry data. After this time data was not obtained.

The AiResearch LO2 boiloff valve satisfactorily maintained LO2 tank pressure between 2.9 and 3.3 psig during LO2 tanking. Landline Measurements F 1001 P, LO2 Tank Helium, and F 1003 P, Fuel Tank Helium, respectively indicated 27.1 psig and 62.3 psig during Sequence III, external; 24.8 psig and 60.5 psig during Sequence III, internal, prior to engine start; and 23.0 to 26.0 psig and 58.7 to 62.0 psig during the engine start transient. Missileborne propellant tank pressures were maintained within respective LO2 and fuel tank pressure specifications of 23.0 to 25.5 psig and 57.0 to 62.0 psig by the Fluidgenics Pneumatic Regulators.

Fuel Tank Pneumatic Regulator Inlet Temperature Measurement F 806 T was added to system instrumentation for comparison with LO2 Tank Pneumatic Regulator Inlet Temperature Measurement F 115 T. Measurement F 806 T indicated 115°F at liftoff and 320°F at 23 seconds. Measurement F 115 T indicated 91°F at liftoff and 320°F at 23 seconds.

Booster Tank Helium Bottle pressure decayed from 3010 psia at liftoff to 2180 psia at 22 seconds. Sustainer Controls Helium Bottle discharge pressure remained at 2950 psia from liftoff to 20.2 seconds. An abrupt decay to 1400 psi occurred at this time and zero pressure was indicated by 21.9 seconds. This was probably the result of a rupture in the system caused by the abnormal environment in the thrust section at this time. A thrust section fire was evidenced starting at 19 seconds.

Five vibration measurements were made on the fuel tank pressure regulator and regulator mount. These measurements provided valid data until the missile was destroyed.

HYDRAULIC SYSTEMS

Hydraulic Systems telemetry measurements were received until 22 seconds when telemetry data became erratic. Booster Engine No. 1 hydraulic accumulator pressure reflected satisfactory transition from ground pressure of about 2000 psia to normal missileborne pressure of 3150 psia. Booster return pressure remained at 90 psia following the normal ignition transient.

Measurement H 130 P, Sustainer Hydraulic Pump Discharge, reflected the abnormal sustainer engine performance. Indicated ground pressure was 1760 psia. Maximum pump discharge pressure after sustainer engine ignition of 2840 psia occurred at 1.2 seconds. The pressure then decayed to system return pressure at 3.6 seconds due to sustainer engine shutdown. Measurement H 191 P, Sustainer High Pressure to Manifold followed the pump discharge decay trend. Measurement H 185 P, Sustainer Hydraulic Pump Inlet, reflected unusual pressure transients during the engine start and liftoff sequences. These were (1) a 52 psi increase from a normal pressure of 80 psia at Range Zero, (2) a 120 psi jump to 198 psia at 1.7 seconds, and (3) a steady decay from 120 psia after 18 seconds. This was the first flight that an increase in pressure has been noted just prior to liftoff, and there is no explanation available. The pressure increase at 1.7 seconds is apparently a result of sustainer engine shutdown and has been observed previously. The decay in pressure after 18 seconds was apparently a result of abnormal conditions in the thrust section.

Measurement H 140 P, Sustainer/Vernier Hydraulic Pressure, reflected the bottoming-out of the sustainer accumulator at 2.2 seconds, and the subsequent decay of the vernier solo accumulator pressure to 1160 psia at 21.8 seconds.

Sustainer hydraulic fluid evacuation prior to liftoff was satisfactory as indicated by Measurement H 1360 P, HPU Sustainer Return, and Measurements H 140 P and H 191 P reflected normal sustainer ground Hydraulic Pumping Unit (HPU) pressure of about 2000 psia at liftoff.

MISSILE ELECTRICAL SYSTEM

Operation of the Missile Electrical System was satisfactory until at least 21 seconds when the telemetry system data became erratic. Prior to this time the missile battery voltage, the inverter Phase "A" and Phase "C" voltages, and the inverter frequency remained within specification.

Two measurements were added to system instrumentation for this flight. Measurement E 118 V, Engine Relay Box, was added to monitor the dc voltage out of the engine relay box on a continuous telemetry channel to assure that no voltage interruptions occur during flight. A large number of engine control relays will drop out and cause engine shutdown if the voltage to the relays is interrupted for ten to twenty milliseconds. Measurement E 118 V did not indicate any voltage interruptions until 23 seconds, coincident with Telemetry System power interruptions.

Measurement E 66 C, Missile DC Amps, was added for confirmation of present design adequacy for additional battery life required for tank fragmentation and ground operating time. This measurement remained between 150 and 167 amperes until 24 seconds. After this time data was erratic.

RANGE SAFETY COMMAND SYSTEM

Performance of the Range Safety Command System was satisfactory. Range Safety action was taken early in flight and the missile was destroyed due to deviation from the prescribed flight trajectory.

Telemetered data indicated satisfactory r-f input/AGC until missile destruction. The Manual Fuel Cutoff signal was decoded at 35.015 $\pm$ 0.1 seconds and the missile was destructed at 35.404 seconds.

AZUSA SYSTEM

Satisfactory operation was indicated. The system acquired automatic track at 4 seconds and went to the fine mode of operation in all parameters by approximately 5.5 seconds. The data were noisy and possibly non-reducible throughout the flight due to flame effects, multipath reception, and lobing. At 24 seconds system operation became completely erratic due to the varying missile attitude.

FLIGHT CONTROL SYSTEM

Performance of the Flight Control System was satisfactory. Mainstage and liftoff transients were normal. Response to the guidance roll maneuver was satisfactory. The pitch program was in normal progress when missile stability was lost at approximately 22 seconds due to loss of B2 Engine thrust. Missile stability had been maintained satisfactorily by the booster engines prior to this time. The sustainer engine position data showed erratic engine motion after liftoff due to loss of hydraulic pressure which was caused by the abnormal sustainer operation.

INERTIAL GUIDANCE SYSTEM

Performance of the Inertial Guidance System was satisfactory. The roll maneuver was generated satisfactorily. All Missile Guidance Set (MGS) components operated properly prior to flight termination. This was the second flight using the Life Improvement Program (LIP) platform.

Target offsets of +0.0072 degrees latitude and -0.0179 degrees longitude were inserted in the Inertial Guidance System to compensate for re-entry vehicle parameters and vernier thrust decay.

Inertial Mode Start occurred at 0955:30.25 EST.

Missile Behavior

The roll maneuver was accomplished by 19 seconds.

At 23 seconds, telemetry quality degraded and abnormal yaw and pitch maneuvers were apparent on the platform resolvers and servo errors.

At 25.85 seconds the platform tumbled in all three axes. Until the tumbling occurred, Guidance System functioning was normal.

Platform and Control

Gyro drifts measured prior to launch were:

Gross Azimuth	-0.57 deg/hr	Precountdown
Roll Fixed	-0.12 deg/hr	X-1 Day
Gross Pitch	-0.13 deg/hr	X-1 Day

Accelerometer scale factors measured during the precount and countdown were as follows:

X	Y	Z
1.99888	1.99939	1.99822

Computer

Computer operation was normal. Data checker evaluation indicated proper computer operation during the period of telemetry reception.

Yaw steering was correct for the flight conditions.

Computer voltages were normal and computer temperature was 29°C.

The data checker tests of the range tape recorded during the countdown indicated proper computer operation and satisfactory telemetry quality.

Alignment Countdown Set

The Alignment-Countdown Set (A-CS) operation was satisfactory. Accelerometer zeros were within the specified lerances before launch, as measured by the A-CS, indicating proper operation of the zeroing loops.

Function	Nominal	Compensated Nominal	Measured	Error
X Offset	0.667	0.822192	0.822534	∕0.000342
X Zero	1.000	1.00000	1.00066	∕0.00066
Y Zero	1.000	1.00000	1.00020	∕0.00020
Z Zero	65.25407	65.19722	65.19903	∕0.00181

Instrumentation

All cnannels of the Analog Signal Converter (ASC) operated satisfactorily. ASC temperature remained constant at 28°C throughout the flight.

The Digital Signal Converter performance was satisfactory.

MOD III RANGE SAFETY AND INSTRUMENTATION SYSTEM

Performance of the Mod III Range Safety and Instrumentation System was satisfactory. A good IIP plot was presented to the Range Safety Officer from liftoff through 27 seconds. Mod III was to be primary for the generation of the Automatic Sustainer Cutoff (ASCO) discrete; however, it was not generated due to premature termination of the flight. The ASCO Inhibit Switch remained in the "Off" position for the entire flight.

Missile position and rate data were available from liftoff until 33.7 seconds and 34.6 seconds, respectively. Preliminary evaluation of the Mod III data indicated that the missile altitude at the time of destruction was approximately 4200 feet. The down range distance traveled by the missile was approximately 1400 feet on an azimuth of 106 degrees.

Performance of the individual subsystems was as follows:

Track Subsystem

Performance of the Track Subsystem was satisfactory. The missile was tracked from liftoff with Mod III in monopulse mode. Normal signal strength was experienced until 19 seconds, at which time the signal strength gradually began to drop. After 27.2 seconds the system began to switch intermittently from monopulse to monopulse memory. All signal was lost at 35.1 seconds.

Rate Subsystem

Rate Subsystem performance was satisfactory. Intermittent range rate and lateral rate data were received until 16.4 seconds when the data became continuously good in all functions. Rate received signal was initially interrupted at 26 seconds. Range rate lock was finally lost at 34.6 seconds.

Mod III Computer

The Mod III Computer operated satisfactorily during the countdown and flight with no malfunctions observed. A simulated flight re-run was made with no deviations from the realtime results.

RE-ENTRY VEHICLE

The RVX-2A was an experimental recoverable re-entry vehicle. The R/V was designed to prove out two types of ablation material and to fly various experiments in which recovery was essential for evaluation of test results. There were fifteen of these J experiments sponsored by several agencies.

The R/V instrumentation carried two R/F links. One of these links carried real time data, and the second transmitter carried the same data, but delayed transmission by forty seconds by using a continuous tape recorder as a delay line. The intelligence carried was on FM/FM/PAM subcarriers.

RVX-2A No.424A performed normally for the conditions throughout the flight. At lift-off all instrumentation was satisfactory. The following significant events were recorded.

T-0	Range Zero
+24	Start of Pitch and Yaw Motion
+35.5	Apparent Explosion
+36.6	Inflight Disconnect
+54.2	Loss of Signal

There was no separation signal observed.

The recovery of debris showed no apparent malfunction.

TELEMETRY

Data from the telemetry system was satisfactory until 21 seconds. At this time the RF 2 Transducer power supply started to vary, and at 22 seconds the RF 1 Transducer power supply was lost.

All data on RF 1 was lost at 32.5 seconds and data from RF's 2 and 3 were lost at 35.4 seconds. There were two measurements not operating properly at the start of the test.

U 81 P	Fuel Tank Head	Reading over 100 per cent before fuel tanking.
A 36 A	B Thrust Section Long Accl.	Bias level had shifted to approximately 24 per cent. This measurement activated but its validity is questionable.

RF 4 operated satisfactorily.

Missile 32E contained three Bendix Mod 7 FM Telemetry packages and one Time Transposition Telemetry package which included a Spiedel Corp. Mod 003 recorder-reproducer system. Basic telemetry channel assignment is given in General Dynamics/Astronautics Report AZC-27-059-32.

PROPELLANT TANKING

Fuel was tanked on X-4 Day, 6 November 1961, to the PLCU overfill probe and secured. Following tanking approximately 25 gallons were drained to facilitate propulsion plumbing repair. On X-1 Day, 25 gallons were topped to return the fuel level to the PLCU overfill probe. On X-Day, at Sequence I pressure, the fuel level was 0.6 cubic feet above the 100 per cent probe. This change in fuel level was apparently due to a ± 0.10 lbs/ft^3 shift in fuel density.

Based on a fuel density of 50.12 lbs/ft^3 and fuel tank volume there were 76,130 pounds of fuel aboard at ignition.

Degree API	43.3
Fuel Temperature (X-4 Day)	77.0°F
Fuel Density (X-4 Day)	50.02 lbs/ft^3
Fuel Density (Ignition)	50.12 lbs/ft^3

LO2 tanking was concluded with a successful LO2 slug transfer of 45 seconds duration, as measured from the first activation of the topping high probe to the activation of the 100 per cent slug cutoff probe. The LO2 slug discharge pressure peaked to 259 psig, dropped rapidly to 229 psig, and then rose steadily to 253 psig at slug cutoff.

At umbilical eject the 100 per cent slug probe was still activated. This would indicate that the LO2 level was still above the probe or that the probe did not respond correctly to the rapid drop in LO2 level associated with ground run consumption.

Based on an ignition LO2 density of 70.38 lbs/ft^3 and LO2 tank volume there were 175,620 pounds of LO2 aboard the missile at ignition.

Weather Data

	Fuel Tanking	Ignition
Pressure	29.925 Inches of Hg	30.040 Inches of Hg
Temperature	74.70°F	70.30°F
Humidity	92.0 Per cent	63.0 Per cent
Wind	6.0 Knots - E-SE	7.0 Knots - N-NE
Cloud Cover	9/10	Clear

LANDLINE INSTRUMENTATION

The Landline Instrumentation System provided satisfactory data prior to liftoff.

AFT-END MOTION DETERMINATION

No data was obtained from the three bottom lights due to smoke obscuring the camera view.

FILM REVIEW

Several fixed camera and tracking camera items were reviewed. None of these items revealed any significant details as to the cause of sustainer engine shutdown at liftoff. Both the fixed and tracking camera data showed the absence of sustainer engine burning after liftoff. Tracking camera data was excellent and also showed the loss of missile stability at approximately 22 seconds concurrent with the shutdown of the No. 2 Booster Engine.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The flight was unsuccessful.

2. Loss of the missile was due to improper design for the installation of a pressure transducer on the sustainer LO2 self-referencing regulator.

3. The AFSWC Pod attachment bolts failed during the countdown.

Recommendations

1. New instrumentation should be thoroughly coordinated with the affected system contractor to insure that the instrumentation will not affect the proper operation of the system.

2. A design review should be made of the area and method of attachment of experimental pods.

COUNTDOWN TIME VERSUS EVENTS

This test was scheduled for a 150 minute countdown and started at 0430 EST as planned. Total countdown duration was 325 minutes. The two holds and one recycle which accounted for 175 minutes were as follows:

1. At -33 minutes (0627 EST) a 126 minute hold was called to remove the AFSWC Package which had become detached from the missile and was wedged between the Scientific Passenger Pod and the missile tank. The countdown was recycled to -70 minutes at 0639 EST.

2. At -3 minutes 30 seconds a 12 minute hold was called while the Range resolved a 7090 Computer problem.

The following notations were made by an observer in the blockhouse.

EST	Countdown Time	Countdown Procedure	Event
0430	T-150	T-150	Countdown Started.
0432	T-148	T-150	GAP Test Preparations Started.
0432	T-148	T-150	Acoustica Sensor Response Check Started.
0441	T-139		Acoustica Response Checks Satisfactorily Completed.
0447	T-133		GAP Test Completed.
0448	T-132		RSC Test Started.
0456	T-124		RSC Test Completed.
0456	T-124	T-125	Red Destruct Box Installation Started.
0501	T-119		RSC Check From Step 30 to Completion Begun - Autopilot Was Not Run Past 215 Seconds on Original Test.

EST	Countdown Time	Countdown Procedure	Event
0508	T-112		RSC Test Completed.
0517	T-103		Red Destruct Box and Retro Rocket Installation Completed.
0518	T-102		AIGS Ready for Landline Removal.
0520	T-100	T-100	Flight Control Systems Test Started.
0528	T-92		Flight Control Systems Test Completed.
0531	T-89		Service Tower Floors Raised.
0548	T-72		Second GAP Test Preparation Started.
0550	T-70		Fuel Tank Flight Level Adjustment Started.
0551	T-69	T-85	Helium Storage Preparation Started.
0556	T-64	T-65	Beacon Checks Started.
0556	T-64	T-65	Landline Electrical Calibrations Started.
0601	T-59		Second GAP Test Satisfactorily Completed.
0608	T-52	T-50	GN2 Topping Gear Secured.
			LO2 Tanking Preparation Started.
0615	T-45		Mod III Beacon Lock On Check Completed.
0616	T-44	T-50	Landline Electrical Calibrations Completed.
0616	T-44		Weather Reported "Go".
0622	T-38	T-35	Tanks Pressurized to Sequence II.

EST	Countdown Time	Countdown Procedure	Event
0627	T-33H		Hold at T-33 and Recycle to T-35 to Make Inspection of Missile After Report of Unusual Noise at Missile.
0628	T-33H		Tank Pressures Restepped to Sequence I.
0637	T-33H		Helium Bottle Pressure Decreased to Below 1500 psi.
0639	T-70H		Count Recycled to T-70 Minutes.
0705	T-70H		Service Tower in Place and Floors Lowered.
0712	T-70H		AFSWC Pod Removed from Between Tank and Scientific Passenger Pod.
0725	T-70H		Telemetry 2 Battery Changed.
0730	T-70H		AFSWC Pod Not to Be Reinstalled.
0740	T-70H		Telemetry No. 1 Battery Changed.
0757	T-70H		Service Tower Floors Raised.
0809	T-70H		Telemetry No. 1 and No. 2 Batteries Activated.
0815	T-70H		Telemetry Check Made on 2 New Batteries.
0822	T-70H		Tower Removal Started.
0826	T-70H		GAP Test Re-run Preparation Started.
0833	T-70	T-70	Count Resumed at T-70.
0839	T-64	T-65	Landline Electrical Calibrations Started.
0839	T-64		GAP Test Satisfactorily Completed.
0851	T-52	T-45	LO2 Tanking Preparation Started.

EST	Countdown Time	Countdown Procedure	Event
0855	T-48		Sequence II Pressurization Started.
0856	T-47		Landline Electrical Calibrations Completed.
0857	T-46		LO2 Tanking Preparation Completed.
0903	T-40	T-35	LO2 Tanking Started.
0913	T-30	T-30	Autopilot System Final Check Started.
0915	T-28		Final Computer Check Started.
0920	T-23	T-23	Azusa Check Started.
0921	T-22	T-22	RSC Final Test Started.
0921	T-22	T-35	Holddown and Release Hooks Retracted.
0923	T-20		Final Accelerometer Checks Started.
0928	T-15		Azusa Test Completed.
0929	T-14	T-14	Nose Cone Beacon and Telemetry on Internal.
0933	T-10	T-10	Telemetry/RSC AGC Check Started.
0936	T-7		Acoustica Checks Completed.
0937	T-6	T-7	Range Final Weather Clearance Reported "Go".
0938	T-5	T-5:00	All Communications Switched to Channel 1.
0938	T-4:30	T-4:30	Squibs Disarm to "off".
0939	T-3:30	T-3:30	Status Check - All Systems "Go".
			Holding for Approximately 3 Minutes for Range.

EST	Countdown Time	Countdown Procedure	Event
0942			Range Hold Extended for Approximately 10 Minutes.
0950			Range Reported Ready.
0951	T-3:30	T-3:30	Count Resumed.
	T-3:30	T-3:30	Telemetry to Internal.
0952	T-3:15	T-3:15	Scientific Passenger Pod to Internal.
0953	T-3:00	T-3:00	Timer Switch to Ready.
0953	T-2:45	T-2:45	Shut Down Power Switch to Arm.
	T-2:05	T-2:05	Commands to Internal.
	T-2:00	T-2:00	Nose Cone Beacon and Telemetry to Internal.
	T-1:55	T-1:55	Autopilot to Arm.
	T-1:50	T-1:50	Turning Water Systems "on".
	T-1:45	T-1:45	Commands to Arm.
	T-1:40	T-1:40	Range Ready Switch "on".
	T-1:35	T-1:35	T-1:35 and Holding Momentarily - All Pre-Start Lights Are Green - Slug Start - Proceeding to Flight Pressurization.
	T-1:10	T-1:10	Missile to Internal Power.
	T-1:05	T-1:05	Missile Helium to Internal.
	T-0:60	T-0:60	T-60 seconds and Holding Momentarily.
	T-0:60	T-0:60	T-60 Seconds and Counting.
	T-0:50	T-0:50	Water Full Flow.

EST	Countdown Time	Countdown Procedure	Event
	T-0:35	T-0:35	Status Check - All Systems "Go".
	T-0:20	T-0:20	All Launch Commit Lights Are Correct.
	T-0:05	T-0:05	T-5 Seconds and Holding Momentarily - All Recorders to Fast.
	T-0:05	T-0:05	T-5 Seconds and Counting.
0955:36			Range Zero.

MISSILE CONFIGURATION

Airframe

The SM-65E Missile is approximately 71 feet long from the re-entry vehicle interface to the aft surface of the thrust chambers. The missile structure is comprised of the booster section and the main propellant tank structure. With the re-entry vehicle attached, the complete missile is approximately 85 feet long.

Azusa System

A type B-1A coherent carrier transponder operated in conjunction with the Mark II Ground Station. The tripod-mounted, elliptical horn antenna was mounted in missile Quad IV.

Electrical System

Electrical system power was supplied by a remotely activated, primary type, Eagle-Picher main missile battery and Leland rotary inverter. A United Controls Power Changeover Switch was flown for the first time.

Flight Control System

The square canister configuration with forward rate gyro canister containing pitch and yaw rate gyros was flown on Missile 32E. This was the first flight using the 27-41002-855 Gyro Canister which incorporated the Phase Rotation Detector System in addition to the Spin Motor Rotation Detector (SMRD) System. This was the fifth flight using the 27-45045-5 Forward Rate Gyro Canister (previously flown on Missiles 2F, 25E, 26E, and 30E) and the third flight using the 27-41000-831 "Transistors" Servo Canister (previously flown on Missiles 25E and 30E). This was the fourth flight using the 27-41001-931 Programmer Canister (previously flown on Missiles 21E, 25E, and 26E).

Guidance System

An ARMA Lot IV Missile Guidance Set (MGS) was flown on Missile 32E. Lot II_m Ground Equipment was used for preflight checkout of the MGS.

Hydraulic Systems

The Hydraulic System flown on Missile 32E was comprised of three independent systems which provided hydraulic pressure for booster operation, sustainer/vernier operation, and a 25 cubic inch accumulator for vernier solo operation. Hydraulic tubing was of aluminum except that directly associated with the sustainer engine, which was of corrosion resistant steel.

Impact Predictors

Azusa System and Mod III Range Safety and Instrumentation System were utilized for impact prediction purposes.

Pneumatic System

Basic Astronautics system was used consisting of five shrouded main propellant tank pressurization titanium helium bottles, and one unshrouded bottle for booster jettison and vernier solo propellant feed. F and G fuel and LO2 tank pressurization regulators, an Airesearch LO2 boiloff valve and Hadley relief valves were utilized.

Propulsion System

Rocketdyne MA-3 Liquid Engine Propulsion System was utilized. Additional instrumentation was utilized to study sustainer engine operation during flight. A time delayed playback recorder was utilized to study engine operation during the booster jettison sequence.

Propellant Utilization System

The Accustica Propellant Utilization system was utilized on this missile. This system uses a 400 cps signal for excitation of the PU valve position feedback transducer and a 5-Card computer. No specific gravity biases were used. A liquid oxygen sensor stillwell assembly and a fuel sensor stillwell assembly ("F" Series) were utilized.

Range Safety Command System

The standard "E" Series system employed two ARW-62 receivers, a power and signal control unit, arming switch, and destruct package. Two manually activated, secondary type, Yardney batteries supplied system electrical power.

Telemetry System

Four airframe telemetry links were operational at 229.9, 227.7, 232.4 and 235.5 mc. Link 4 (235.5 mc) contained Link 1 Channels 5, 6, 7, 8, 9, 10, 11, 12, 13, A, C and E time delayed by 1.5 seconds through a Speidel tape recorder.

Electrical power for the airframe telemetry canister was supplied by three remotely activated, primary type, Eagle-Picher batteries.

Mod III Range Safety and Instrumentation System

The Mod III E Instrumentation Beacon System operated in conjunction with the Mod III Ground System. The "twisted" missileborne antenna (Part No. 27-136010-3) was mounted on the tripod boom in missile Quad IV.

Propellant Tanking

Astronautics "E" Series Propellant Tanking System was used incorporating four ultrasonic fuel sensors, four LO2/GO2 detectors, a Propellant Loading Control Unit (PLCU) in the blockhouse, and 200-400 gallon LO2 slug.

Re-entry Vehicle

Missile 32E was the last flight test of the RVX-2A Re-entry Vehicle which was an instrumented, recoverable, research test vehicle. Two FM/FM VHF transmitters, a C-Band beacon, a playback recorder for re-entry data and a recoverable tape recorder comprised the instrumentation sub-system. Fifteen space laboratory experiments were also aboard the RVX-2A Re-entry Vehicle.

AFSWC Pod

An Air Force Special Weapons Command Pod was installed for upper atmosphere studies.

Scientific Passenger Pod

SP Pod 13 was carried for assigned experiments on Liquid Hydrogen Zero-G Heat Transfer and Spectrum Analyzer Tests.

HISTORY OF SM-65E MISSILE NO. 32E

Atlas Missile 32E arrived at AMR by air (C-133) on 5 October 1961. Transfer from the IOC trailer to the R and D trailer was completed and the missile was placed in Hangar "J" to receive a minimum of hangar testing. On 9 October 1961 Missile 32E was weighed. Missile transfer to Complex 13 and erection were completed on 9 October. Preflight testing was accomplished in accordance with planning documented in Report AA 61-0148, Flight Test Directive, Atlas Missile 32E.

Significant events concerning Atlas Missile 32E from arrival at AMR to launch are delineated below:

Date	Event
5 October 1961	Arrived at AMR.
9 October 1961	Missile Weighing.
9 October 1961	Transferred to Complex 13 and erected.
5 November 1961	Successful Flight Acceptance Composite Test.
6 November 1961	Successful Propellant Tanking.
9 November 1961	Attempted Launch (Terminated during precount when V1 engine developed a gimbal shaft hydraulic leak)
10 November 1961	Flight

A brief description of significant difficulties encountered in system preparation and testing accomplished at AMR is as follows:

Landline Instrumentation

No significant problems were encountered.

Missile Electrical

The Leland inverter was removed for engineering evaluation and replacement of a diode. Following reinstallation on the missile Procedure 27-93669-Bk 1B was re-run for a check.

All test procedures were satisfactorily performed.

Range Safety Command

During the performance of the Telemetry Blockhouse Compatibility Test, 27-90361-1B, the RF System ready switch was turned on thus arming the RSC System. After turning off the RF System ready switch, the RSC System could be returned to safe, but the "Missile Safe" light could not be obtained on the RF System panel. The fault was traced to defective contacts in the motor driven switch in the RSC Electrical Arming Device. The electrical arming device was replaced by IR 679205 and the RSC System Test (27-93665-Bk 1C) was re-run to verify proper system operation.

Azusa

No significant problems were encountered

Telemetry

During inspection of Vernier No. 1 Engine prior to installation, the transducer for Measurement P 28 P was IR'd due to the insulation on the harness having been cut through to the conductors. The transducer was replaced.

Harness 27-11493-1 from Telemetry RF No. 1 to telemetry RF No. 4 was IR'd on 2 November because it was not assembled per blueprint. This harness arrived at AMR already fabricated. The harness configuration was acceptable and was used as is.

Telemetry RF No. 4 assembly, Serial No. 1 was IR'd on 3 November because of indications of 100 kc reference oscillator intermittent dropout. Telemetry RF No. 4 assembly, Serial No. 2 was installed.

Telemetry RF No. 1, Serial No. 0868 was IR'd on 4 November 1961 because of an internal wiring problem which shorted the five volt calibration voltage to ground. RF No. 1, Serial No. 9V16 was installed.

Telemetry RF No. 2, Serial No. 0751 was IR'd on 4 November 1961 because of a grounded wiper.

IR'd and replaced on 4 November the transducer assemblies for Measurement A 35 T and A 58 T because of broken thermistor wires.

Telemetry RF No. 2, Serial No. 0238 was IR'd on 5 November because of an open master pulse on Channel E. Installed RF No. 2, Serial No. 0751.

Telemetry RF No. 1, Serial No. 9V16 was IR'd on 5 November because of a bad commutator motor on Channel C. This discrepancy was corrected in the Telemetry Lab and RF No. 1, Serial No. 9V16 was reinstalled.

Telemetry RF No. 4, Serial No. 2 was IR'd on 6 November because of an indication of an unstable frequency output. Installed RF No. 4, Serial No. 1. This problem was later discovered to be a broken coax conductor between RF No. 1 and RF No. 4 which was repaired.

IR'd and replaced on 8 November the transducer assemblies for Measurements A 35 T and A 58 T because of broken thermistor wires.

IR'd the Accessory package, Serial No. 103-0018 on 8 November 1961, because of an unstable transducer power supply No. 1. Installed Accessory Serial No. 010-0011.

Flight Control

The rate gyros could not be torqued because the rate gyro ±30 volts amp supply return line ZN268A20 was spliced into the torque rate gyro line, ZN263A20, which loaded down the Sorensen power supply. The harness was reworked to print configuration.

The programmer pre-arm signal was interchanged with the nose cone umbilical jettison signal in order to accomplish ejection of the nose cone umbilical prior to nose cone ejection. An error in the harness as received from San Diego was corrected to make the circuit compatible with the RVX-2A.

Mod III Instrumentation Beacon

During installation of the waveguide it was discovered that the waveguide was twisted preventing mating at the window. The waveguide was IR'd straightened, pressure tested, and functionally checked.

A broken Camloc fastener on the rate beacon mount was discovered during installation. The mount was IR'd and replaced (IR No. 669870).

Hydraulics

During pre-countdown operations on 9 November 1961 the V1 Engine developed an excessive hydraulic leak at the gimbal shaft bleed port. The engine was replaced.

Propellant Utilization

During performance of 27-90480-Bk 1A, Acoustica P/U System Calibration, erroneous voltages were discovered on computer reset and error counter output circuits. Investigation revealed an intermittent short circuit between Pins "M" and "N" of Plug 204U1P1. P/U Harness, 27-61825-927 was IR'd and Connector 204U1P1 was replaced with no subsequent problems. A failure analysis on the old connector revealed a strand of shielding wire i bedded in the potting compound but not in an area to cause a short circuit. After the connector was replaced, all accessible P/U harnesses were moved and shaken while monitoring telemetry P/U functions. No discrepancies were observed.

Propulsion

During sustainer LO2 self referencing resulator inspection (GMA 10843A) internal parts were found corroded. The regulator was IR'd (IR No. 669861) and dispositioned as being acceptable for flight by Rocketdyne engineering.

During heater thermostat megger checks the sustainer igniter fuel valve and B1 main LO2 valve heater thermostats failed to meet minimum requirements (50 megohms). Both were IR'd and replaced. The replacement thermostat on the igniter fuel valve was also IR'd for low resistance (IR 679233). During replacement the plug was found wired incorrectly. Further checks revealed that the B1 main LO2 valve heater plug was also wired incorrectly. Both plugs were re-wired per B/P and heaters functioned properly.

The LO2 topping rise-off disconnect appeared to have been cleaned without removing the 27-29096-7 Kel-F lip seal, resulting in seal distortion and leakage. The LO2 topping rise-off disconnect was replaced.

During LO2 tanking, the 27-21507-1 LO2 Topping Line collapsed, at the start of slug delivery and the LO2 topping disconnect (ground half) closed, preventing further slug delivery. The topping disconnect (ground half) was contaminated during replacement of the LO2 topping line and was replaced.

During fuel tanking, a pouring fuel leak was found at the B2 directional control valve mounting flange. The seal was found cut with approximately 1/4 inch protruding from the edge of the mounting flange. Missile was detanked and seal was changed.

During pre-countdown operations, the V1 Engine developed an excessive hydraulic leak at the gimbal shaft bleed port. The engine was replaced.

Complex Mechanical

During erection preparations, water was found in the erection motor gearcase oil and the erection brake. The gearcase oil was drained and the case refilled. The brake was drained and wiped dry. No over-heating of the assembly was noted during the erection operation.

The initial attempt at an LN2 shroud cold test was prematurely terminated because of excessive leakage in the airborne system. Fog prevented exact location of the many leaks. Fittings were tightened and coated with zinc-chromate paste per IR. The second attempt was satisfactorily completed with no apparent leakage.

Missile 32E was equipped with a special adapter to support the RVX-2A Nosecone. To give stretch capability with this modification a 7-91060 Stretch Sling assembly was installed. After the fuel and LO2 tanking test, the AN4C-12 Bolt which connects the tension bar to the donut in Quad IV was found sheared, causing three MS-20004-6 Bolts which connect the tension bar to the adapter to fail. This failure caused loss of stretch capability until repair could be made. Had the RVX-2A Nosecone been on, it could have seriously damaged the missile. It cannot be determined if bolts broke during tanking or when stretch was applied.

Complex Electrical

A failure was encountered in the PLCU LO2 Hi-topping amplifier A102, Part No. 27-43021-1. This was due to a defective diode which was replaced on an IR resulting in proper operation of the PLCU.

Sustainer Ignition Fuel Valve Thermostat Jack J57 exhibited low impedence to ground during megger check. Jack J57 was replaced per IR No. 679233 and rewired to print. Subsequent megger check was acceptable.

Boiloff valve closed light did not indicate during boiloff exercises. Investigation indicated the boiloff closed light was wired incorrectly into the differential pressure warning system. IR No. 679259 was issued against the harness to rework per blueprint. This was accomplished and the boiloff valve closed light then performed satisfactorily.

Propellant Loading

No significant problems were encountered.

Airframe

During the countdown, the AFSWC Pod fell from its mounting brackets upon proceeding to Sequence II pressures in the fuel tank and wedged itself between the S.P. Pod and the missile tank skin. The tank skin was dented and IR'd. AMR and San Diego Design personnel inspected the dent and found it acceptable for flight. The AFSWC Pod was not flown.

Pneumatics

After installing the special adapter to support the RVX-2A Nosecone, the LO2 Tank Sensing Line (27-81023-57) was too short to reach the boss which connects it into the tank. TVA 32686 was released which fabricated a new line for this configuration. A duplicate line was fabricated and routed to San Diego as a pattern for any similar configurations in the future.

Missile 32E was equipped with an AiResearch boiloff valve. Upon installing this valve it was found that the 27-80751-91 vent line was too short and would not line up properly with its fittings. A new line was fabricated to fit the installation. The 27-80751-49 tank sensing line was also found to be short. This line was remocked per TVA A39723. Special manhole adapter also did not fit so one was procured from Point Loma. This had to be modified to install LO2 loading probes.

Inertial Guidance

On 6 October 1961 Missile System Checkout (CTP-40) was started. Due to trouble in the Inductosyn, which was traced to an open circuit in the missile umbilical, this test was not completed.

On 10-12 October 1961, commenced GSE and MGS checkout. Repaired Azimuth Servo PPI amplifier in the GSE. Changed Azimuth readout dial for non-dogleg flight. Completed partial MGS System Test (CTP-42, only).

On 13 October 1961, continued MGS System Test (CTP-39 portion). Unable to obtain Azimuth alignment properly. The problem was found to be in the Inductosyn loop.

On 17 October 1961, the Inductosyn trouble was found to be caused by a problem in the booster amplifier circuit. Corrected same, and completed a satisfactory MGS System Test.

On 2 November 1961, ran Computer problem. Received yaw steering dropouts and "No-Go" lights. After considerable trouble shooting, the dropouts ceased, but "No-Go" lights were still received. Replaced Computer Serial No. 7230010 with Computer Serial No. 7230021.

On 2 November 1961 replaced Platform Serial No. 7210064 and Control Serial No. 8220045 with LIP Platform Serial No. 7210172 and Control Serial No. 7220030, per special directive of Arma/GCY. (The 32E pod is equipped with special cooling process developed expecially for LIP Platform testing).

On 5 November 1961 conducted a satisfactory FAC Test. The Roll Servo error and the Redundant Torquer gave peculiar indications during this test. This will be investigated.

On 7 November 1961 commenced Readiness (X-1) Day checks, in preparation for launch. (CTP-42B, 39A and 45) The computer was not operating properly. SCO and VCO occurred at approximately 0.3 and 0.4 seconds. Computer Serial No. 7230010 was removed and replaced with Computer Serial No. 7130015.

In addition, the ASC was rejected due to high noise level on the Roll Servo Error Channel No. 34. ASC Serial No. 020 was removed and replaced by ASC Serial No. 7130013.

On 7 November 1961 re-ran additional computer problems and received a "No-Go" indication. Discovered burned resistor in the 4300 panel of the GSE. Replaced burned-out resistor and ran a series of computer problems, all of which were "Go".

On 10 November 1961, conducted precount operations for Missile 32E launch. Due to the high pitch cable torque experienced previously, the Pitch Gimbal was very difficult to bring to the Scale X-1G position. Because of this condition, it was necessary to run the Accelerometer scaling during the Precount.

Scientific Passenger Pod

After arrival of Pod 13 at AMR it was found that telemetry Channels 5 and 8 which carry identical data were inoperative. A check of the telemetry system and blueprints revealed that improper wiring had been accomplished. The wiring was corrected per IR 672949 and the problem was eliminated.

An attempt was made to place the pod on the handling truck but during the attempt it was found that the bottom of the pod interferred with the floor due to the attachment of a stabilizing device on the bottom of the pod. The condition was corrected by TVA A-32423 which provided four inch elevating blocks under each wheel of the handling truck.

During checkout of the telemetry plate in the telemetry laboratory Channels 11, 12, and 16 were found to be out of specification. The condition was corrected by replacement of all three of the channel oscillators.

Special instrumentation to monitor venting of the 9 inch and 22 inch CH2 spheres was installed on the SPP tower to assure proper vent shutoff prior to ignition.

Re-entry Vehicle

RVX-2A, No. 424A arrived at AMR on 22 May 1961. Because of Flight Schedule changes, no work was performed on the R/V until much later. Completion of hangar tests were as follows:

Systems Confidence Test	9-5-61
Telemetry Systems Test	9-6-61
Sensor Stimulation	8-31-61
Beacon Tests	10-31-61
Final Acceptance Test	11-2-61
Experiment Tests Complete	11-6-61
Cook Recovery Package Installation	11-6-61

APPENDIX

FLUID CHEMICAL ANALYSIS

	Unit	Sample A	Sample B	Specification
Liquid Oxygen				
Purity	Per cent	99.4		99.2 Minimum
Hydrocarbons				
As Methane	ppm by vol.	19		75 Total Maximum
As Acetylene	ppm by vol.	None		1.5 Maximum
Particle Count				
350 - 500	Microns	None		2 Maximum
500 /	Microns	None		0
Fiber 25 x 6000	Microns	None		0
Total Solids	Microns	None		2.5

This item is within specifications.

Gaseous Helium				
Purity	Per cent	99.95/		99.95 Minimum
Hydrocarbons				
As Methane	ppm by vol.	None		75 Total Maximum
As Acetylene	ppm by vol.	None		1.5 Acetylene

This item is within specifications.

Gaseous Nitrogen				
Purity	Per cent	99.6		99.5 Minimum
Hydrocarbons				
As Methane	ppm by vol.	None		75 Total Maximum
As Acetylene	ppm by vol.	None		1.5 Maximum

This item is within specifications.

	Unit	Sample A	Sample B	Specification
Lubricating Oil				
Viscosity at 100°F	Centistokes	12.71		11.0 Minimum
Viscosity at 210°F	Centistokes	3.33		3.0 Minimum
Flash Point	°F	452		400.0 Minimum
Viscosity Index		149.4		80.0 Minimum
Appearance		Pass		Uniform. No sediment or suspended matter.
This item is within specifications.				
Tricloroethylene				
Appearance		Pass		Clear
Color		Pass		Not Dyed
Odor		Pass		Characteristic
Specific Gravity	@68°/68°F	1.468		1.454 to 1.476
Distillation				
Initial	°C	188.2		187.7 Minimum
Dry Point	°C	188.5		190.4 Maximum
Water Content	@14.0°F	Pass		Cloudless
IR Absorbance	Per cent	.0003		.0005 Maximum
Non-volatile	Per cent	.0005		.002 Maximum
This item is within specifications.				
Fuel, RP-1				
Initial Boiling	°F	347		Report
10 Per cent	°F	380		365 - 410
50 Per cent	°F	418		Report
90 Per cent	°F	452		Report
End Point	°F	481		525 Maximum
Residue	Per cent	0.8		1.5 Maximum
Loss	Per cent	0.3		1.5 Maximum
Flash Point	°F	137		110 Minimum
Gravity	°API	43.3		42.0 - 45.0

	Unit	Sample A	Sample B	Specification
Fuel, RP-1 (con.)				
Particle Count				
350 - 500	Microns	10		20 per liter
500 /	Microns	None		0
Fibers 25 x 6000	Microns	None		0
Inert Solids	Milligrams	0.8		1.5 Max. per liter
Moisture Content	Per cent	None		

This item is within specifications.

Hydraulic Fluid		Booster	Sustainer	
Flash Point	°F	210	216	200.0 Minimum
Viscosity	Centistokes	8.70	8.35	8.0 to 10.0
Color		Clear	Clear	Clear
Dye		Red	Red	Red
Particle Count				
10 - 25	Microns	2,400	3,600	5,000 Maximum
26 - 50	Microns	600	900	1,000 Maximum
51 - 100	Microns	120	180	300 Maximum
100 - 200	Microns	3	11	20 Maximum
Fibers	Microns	2	6	10 Maximum

This item is within specifications.

REFERENCE DOCUMENTS

Flight Test Plan - Missile No. 32E	AE 60-0802
Flight Test Program - SM-65 Series E, R & D Missiles	AZC-27-005
Detailed Test Requirements (AFBMD/STL)	STL/OR-60-0000-19028
Flight Test Directive (FTWG)	AA 61-0148

Additional reports which may be referenced for further information regarding this missile are listed below:

Reports	Approximate Issue Date (time after test)
Acoustica Associates, Inc., Los Angeles, Calif.	
Flight Test Evaluation Report	30 days
General Dynamics/Astronautics, San Diego, Calif.	
Flight Test Evaluation Report	14 days
AFBMD/STL, Inglewood, Calif.	
Flight Summary Report	8 - 12 weeks
ARMA, CCO	
CCO Quick Look Report	7 - 10 days
American Bosch ARMA Co., Garden City, N.Y.	
Flight Test Evaluation Report	30 days
General Electric, Philadelphia, Pa.	
Evaluation Report	30 days
General Electric, Syracuse, N.Y.	
Evaluation Report of Mod III Instrumentation System with Missile 32E	6 - 10 weeks

SERIAL NUMBERS OF SYSTEM COMPONENTS

Azusa Transponder

Canister, Serial No. 731-0077

Re-entry Vehicle, RVX-2A, Serial No. 424A

Range Safety Command System

Range Safety Command Receiver No. 1, Serial No. AF60-132
Range Safety Command Receiver No. 2, Serial No. AF58-272
Range Safety Command Receiver No. 1, Battery, Serial No. 011-0499
Range Safety Command Receiver No. 2, Battery, Serial No. 011-0498
Range Safety Command Power and Signal Control Unit, Serial No. 010-0030

Propulsion System

Sustainer, Serial No. 222744
Booster No. 1, Serial No. 112747
Booster No. 2, Serial No. 112788
Vernier No. 1, Serial No. 332796
Vernier No. 2, Serial No. 332753

Electrical System

Main Missile Battery, Serial No. 107-0475
Inverter, Serial No. 002-0063
Power Changeover Switch, Serial No. 108-0223

Mod III E Instrumentation Beacon System

Rate Beacon, Serial No. 6E8042
Pulse Beacon, Serial No. 6E1033

Telemetry System

Telemeter RF No. 1, Serial No. 0868
Telemeter RF No. 2, Serial No. 0238
Telemeter RF No. 3, Serial No. 0136
Telemeter RF No. 4, Serial No. 1
Telemeter RF No. 1, Battery, Serial No. 104-0563
Telemeter RF No. 2, Battery, Serial No. 104-0567
Telemeter RF No. 3, Battery, Serial No. 104-0564
Accessory Canister, Serial No. 010-0011

Flight Control System

Gyro Canister, Serial No. 011-0039 (223)
Forward Rate Gyro Canister, Serial No. 108-0105 (96)
Servo Canister, Serial No. 109-0119 (239)
Programmer Canister, Serial No. 104-0018 (229)

Propellant Utilization System

Computer, Serial No. ACA-0084

Pneumatics System

LO2 Tank Pressure Regulator, Serial No. 007-0053
Fuel Tank Pressure Regulator, Serial No. 008-0059

Inertial Guidance System

Platform, Serial No. 7210172
Control, Serial No. 7220030
Computer, Serial No. 7130015
Analog Signal Converter, Serial No. 7150013
Digital Signal Converter, Serial No. 7140050

Scientific Passenger Pod, Serial No. 13

SIGNIFICANT DATES DURING TESTING OF "A" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
4A	12-8-56	14	3-22-57	6-3-57	6-11-57	895	Engine shut down at 29.9 seconds of flight. Missile destroyed at 50.1 seconds.
6A	4-4-57	14	8-2-57	9-20-57	9-25-57	1422	Engine shut down at 47.7 seconds of flight. Missile destroyed at 74 seconds.
12A	11-1-57	14	11-20-57	12-11-57	12-17-57	2148	Successful flight. Impacted approximately 490 nm downrange.
10A	7-18-57	12	9-27-57 10-27-57 11-6-57	*11-27-57 **12-10-57 1-4-58	1-10-58	10	Successful flight. Impacted approximately 542 nm downrange.
13A	12-4-57	14	1-17-58	***1-31-58	2-7-58	222	Engine shut down prematurely at 117.8 seconds of flight due to flight control system failure Missile broke up at 167 seconds.
11A	12-28-57	12	1-25-58	2-8-58	2-20-58	449	Engine shut down prematurely at 124 seconds of flight due to flight control system failure. Missile broke up at 126.5 seconds.
15A	1-6-58	14	2-26-58	3-22-58	4-5-58	634	Engine shut down prematurely at 105 seconds of flight due to B1 turbopump failure. Missile remained intact and impacted approximately 200 miles downrange.
16A	2-5-58	12	3-17-58	****4-18-58 5-22-58	6-3-58	1261	Successful flight. Impacted approximately 480 nm downrange.

* Premature cutoff at 8 seconds. Both booster chambers damaged, necessitating replacement.

** Full duration, but damaged B1 chamber, necessitating replacement.

*** FRF terminated prematurely, but considered satisfactory.

**** Prematurely terminated due to APS shutdown.

SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
22E	6-4-61	13	6-14-61	None	7-6-61	[illegible]	First "E" Series missile to be successfully flown to a maximum range target of 7863 nautical miles with impact within 2.1 nautical miles of target.
21E	6-24-61	11	7-5-61	None	7-31-61	1360	Impacted a Mark 5 Mod I Re-entry Vehicle within 3.1 nautical miles of target at a range of 4388 nautical miles.
26E	7-7-61	13	8-9-61	None	9-8-61	1803	Flight prematurely terminated when the sustainer engine shut down during booster jettison sequence. Operation of all other systems was satisfactory.
25E	7-18-61	11	8-14-61 9-7-61*	None	10-2-61	1252	Impacted a Mark 5 Mod I Re-entry Vehicle within 1.5 nautical miles of target. A scientific passenger pod containing Centaur Guidance System was carried for the first time. * Re-erected after complex modification to "F" Series.
30E	8-22-61	13	9-12-61	None	10-5-61	1804	Fourteenth "E" Series missile to be flight tested at AMR. First flight for a Mark 4 Re-entry Vehicle to a long range target of 7539 nautical miles. All prime objectives were satisfied.

SIGNIFICANT DATES DURING TESTING OF "C" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3C	10-31-58	12	11-4-58 *11-25-58	12-17-58	12-23-58	2501	Successful flight. Impacted approximately 3803 nm downrange.
4C	11-9-58	12	1-6-59	1-19-59	1-27-59	10	Although impact was close to intended point, the guidance system did not function.
5C	1-31-59	12	2-4-59	None	2-20-59	251	Missile exploded at 174 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
7C	2-12-59	12	2-23-59	None	3-18-59	761	Booster engine shutdown prematurely at 131 seconds of flight. Missile was unstable for remainder of flight.
8C	5-7-59	12	5-11-59	**5-22-59 **7-9-59	#7-13-59 7-21-59	2103	Successful flight. Impacted in target area 4385 nm downrange. RVX-2 Re-entry Vehicle recovered.
11C	7-15-59	12	7-25-59	8-14-59	8-24-59	2121	Successful flight. Impacted almost 5 miles long in MILS net due to residual thrust after vernier cutoff. Re-entry vehicle was recovered.

* After power pack modification.

** Two successful Flight Readiness Firings performed.

\# Ignition achieved twice. Manual cutoff for 1st. attempt in vernier ignition phase. Second attempt terminated by release timer.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3D	2-25-59	13	2-27-59	3-27-59	4-14-59	1002	Booster section exploded 27 seconds after liftoff due to failure of airborne LO2 fill and drain valve to close. Missile destroyed at 37 seconds.
7D	3-20-59	14	4-13-59	5-8-59	*5-15-59 5-18-59	1754	Missile exploded at 65 seconds due to improper launcher operation which resulted in loss of fuel tank pressure.
5D	3-8-59	13	4-28-59	5-15-59	6-6-59	1753	Missile exploded at 160 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
11D	4-10-59	11	5-11-59	**7-14-59 7-22-59	7-28-59	2002	Successful flight. Impacted 4384 nm downrange less than 1/2 mile from target in MILS net.
14D	5-7-59	13	6-10-59	7-28-59	8-11-59	2003	Successful flight. Impacted in MILS net less than 1 mile from target.
17D	5-27-59	13	8-17-59	9-9-59	9-16-59	2106	Successful flight. Impacted 2 miles short of target in MILS net due to failure of vernier solo hydraulic package.
18D	5-27-59	11	9-2-59	None	10-6-59	2120	Successful flight. Impacted in MILS net less than 1/2 mile from target.
22D	8-26-59	13	9-21-59	None	10-9-59	3505	Successful flight. Impacted in MILS net less than 1 1/2 miles from target.
26D	9-18-59	11	10-8-59	None	10-29-59	2344	Due to malfunction of V2 engine at staging, impacted approximately 14 miles short of target point.
28D	9-18-59	13	10-14-59	None	11-4-59	4203	Unsuccessful. A/B IP failure prevented Station 5 IP system from acquiring the missile. Range safety cutoff caused R/V to impact approximately 260 miles short of target.
15D	5-9-59	11 14 13	7-11-59 9-23-59 11-7-59	None	11-24-59	2105	Successful although re-entry vehicle did not seperate. Impacted in MILS net.
31D	10-10-59	13	11-28-59	None	12-8-59	4205	Successful flight. Impacted 1/2 mile from target in MILS net.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
40D	11-20-59	13	12-10-59	None	12-18-59	16	Successful flight. Delivered a Mk-2 Re-entry Vehicle within 3 nm of target over a 5500 nm range.
43D	12-8-59	13	12-22-59	None	1-6-60	32	Successful flight. Delivered a Mk-3 Re-entry Vehicle within 3 miles of target over a 5500 nm range.
44D	12-17-60	13	1-11-60	None	1-26-60	54	Successful flight. RVX4-A2 Re-entry Vehicle impacted approximately 1/2 mile from target in MILS net.
49D	1-5-60	13	1-28-60	None	2-11-60	320	Successful flight. Mk-3 Re-entry Vehicle impacted less than 1 1/2 nm from target over a 5500 nm range.
42D	12-5-59	11	12-21-59	#2-4-60 2-23-60	##3-4-60 3-8-60	17	Successful flight. First missile to use all-inertial guidance system open loop.
51D	1-29-60	13	2-15-60	None	3-10-60	775	Destroyed by fire and explosion immediately after liftoff.
48D	2-19-60	11	3-10-60	None	4-7-60	301	Destroyed in the stand by fire and explosion during a launch attempt.
56D	3-3-60	12	4-11-60	None	###5-12-60 5-20-60	1885	Successful flight. Delivered Mk-3 Re-entry Vehicle within 4 nm of target over an extended range of 7859 nm.
54D	2-25-60	11	5-13-60	None	6-11-60	615	Successful flight. Delivered Mk-3 Re-entry Vehicle 4306 nm downrange within 2.2 nm of target. First flight with AIG system providing active guidance functions.
62D	4-19-60	14	5-26-60	None	6-22-60	801	Impacted approximately 18 nm long due to failure of the vernier engines to shutdown when the guidance cutoff discrete was received.
27D	5-27-60	12	6-4-60	None	6-27-60	1002	Successful flight. Impacted within 1 nm of target in MILS net 4388 nm downarange.
60D	4-5-60	11	6-14-60	None	7-2-60	803	Inadvertent pressurizations of the engine tanks caused premature depletion of control helium. Re-entry vehicle impacted 40 nm short.
32D	6-22-60	12	7-1-60	None	####6-2-60 8-9-60	1003	Successful flight. Impacted within 4 nm of target in South Atlantic Ocean over the intermediate range of 6350 nm.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
66D	6-16-60	11	7-7-60	None	8-12-60	1004	Successfully impacted re-entry vehicle within 2 nm of target. First Atlas to use AIG system with impact programmed for Station 12 *MILS* net.
76D	7-6-60	11	8-15-60	None	9-16-60	2817	Successfully placed RVX-2A Re-entry Vehicle within 5 nm of target. Second Atlas to use AIG System with impact in Station 12 *MILS* net.
79D	7-13-60	14	8-26-60	None	***9-15-60 9-19-60	802	Successful flight. Second Atlas to deliver a Mark 3 Re-entry Vehicle to target over an extended range of 7863 nm.
71D	8-19-60	11	9-26-60	None	10-13-60	1502	Successful flight. Impacted within 2 nm of target 4387 nm downrange. Last D-AIG Missile to be flight tested. RVX-2A Re-entry Vehicle recovered.
55D	2-27-60	12	3-7-60 5-24-60 10-3-60	None	10-22-60	613	Successful flight. Impacted within 1 nm of target 6350 nm downrange. The missile was flown without insulation and insulation bulkhead at the intermediate bulkhead with no adverse results.
63D	10-6-60	12	10-27-60	None	11-15-60	3503	Successful flight. Impacted less than 1 nm from target 4388 nm downrange. Data cassette recovered.
90D	12-14-60	12	12-20-60	None	1-23-61	3505	Successful flight. Last of "D" Series Weapon System flights. Impacted Mk-3 Mod 1B Re-entry Vehicle within 1/2 nm of target 4394 nm downrange.

* Launch aborted due to faulty release timer which initiated automatic cutoff.

** Test terminated by sustainer rough combustion cutoff circuitry.

*** Launch aborted 5.45 seconds after sustainer flight lockin because no release signal was generated.

Rerun due to Guidance System difficulties.

Engine cutoff prior to relea - due to erroneous callout in blockhouse.

Terminated by erroneous output from B2 primary RCC accelerometer.

Terminated 1.53 seconds after sustainer flight lockin by the sustainer RCC system.

SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3E	5-19-60	13	7-29-60	*9-23-60 10-3-60	10-11-60	1502	Malfunction in sustainer hydraulic system caused loss of missile after staging.
4E	7-15-60	13	10-21-60	None	11-29-60	2800	Sustainer hydraulic pressure was lost at 41 seconds and caused missile to become unstable at booster cutoff. Sustainer thrust was lost at about 150 seconds.
8E	10-25-60	13	12-5-60	None	2-24-61	3504	Missile stability was not maintained after 161.8 seconds due to loss of engine servo control in flight control system. Sustainer engine shutdown at 249 seconds.
9E	11-11-60	13	1-30-61	None	2-24-61	3803	Successful flight. Impacted Mark 3 Mod II B Re-entry Vehicle within 600 yds. of aim point.
13E	1-13-61	13	2-27-61	None	3-13-61	403	Malfunction in PU system caused fuel depletion and premature shutdown of sustainer engine at 252 seconds.
16E	3-10-61	13	3-14-61	None	3-24-61	811	Failed to jettison the booster section because of premature depletion of engine control bottle helium pressure.
12E	12-20-60	11	2-16-61	None	5-12-61	404	Successful flight. Impacted Mark 5 Mod I Re-entry Vehicle within 0.5 mile of target at a range of 4388 miles. First "E" Series from Complex 11.
18E	3-30-61	13	4-5-61	None	5-26-61	813	Successful flight. Impacted Mark 4 Mod IV Re-entry Vehicle 1 mile of target at a range of 4388 nautical miles. First "E" Series missile flown without insulation and insulation bulkhead at the intermediate bulkhead with no adverse results.
17E	3-21-61	11	5-18-61	None	6-22-61	812	Unsuccessful flight. Malfunction in the Flight Control System caused loss of missile after 101 seconds.

* B2 lube oil pump shaft sheared. Test duration 14 seconds.

SECRET

SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
22E	6-4-61	13	6-14-61	None	7-6-61	12[illegible]1	First "E" Series missile to be successfully flown to a maximum range target of 7863 nautical miles with impact within 2.1 nautical miles of target.
21E	6-24-61	11	7-5-61	None	7-31-61	1360	Impacted a Mark 5 Mod I Re-entry Vehicle within 3.1 nautical miles of target at a range of 4388 nautical miles.
26E	7-7-61	13	8-9-61	None	9-8-61	1803	Flight prematurely terminated when the sustainer engine shut down during booster jettison sequence. Operation of all other systems was satisfactory.
25E	7-18-61	11	8-14-61 9-7-61*	None	10-2-61	1252	Impacted a Mark 5 Mod I Re-entry Vehicle within 1.5 nautical miles of target. A scientific passenger pod containing Centaur Guidance System was carried for the first time. * Re-erected after complex modification to "F" Series.
30E	8-22-61	13	9-12-61	None	10-5-61	1804	Fourteenth "E" Series missile to be flight tested at AMR. First flight for a Mark 4 Re-entry Vehicle to a long range target of 7539 nautical miles. All prime objectives were satisfied.

SIGNIFICANT DATES DURING TESTING OF "F" SERIES FLIGHT MISSILES AT AMR

MISSILE	Arrival	Complex	Erection	PRF	Flight	AMR Range No.	Comments
2F	7-2-61	13	7-12-61	None	8-8-61	1805	First "F" Series Missile to be flight tested. Impacted Mark 5 Mod I Re-entry Vehicle 4388 nautical miles within 2.1 nautical miles of aim point.

SIGNIFICANT DATES DURING TESTING OF MERCURY/ATLAS VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
10D	4-10-59	14	6-2-59 *7-22-59	9-3-59	9-9-59	2119	Successful flight although booster section failed to jettison. Project Mercury Capsule recovered.
50D	5-17-60	14	6-30-60	7-21-60	7-29-60	1505	Unsuccessful. Missile apparently destroyed after 60 seconds of flight. Mercury Capsule remained intact until impact.
67D	7-8-60	14	11-4-60	11-19-60	2-21-61	419	Successful MA-2 mission. Impacted Mercury Capsule as planned. First closed loop flight for ASIS. Capsule recovered.
100D	3-14-61	14	3-27-61	None	4-25-61	835	Unsuccessful. Missile was destroyed by range safety action 40 seconds after lift-off. This action was necessitated by the absence of the roll and pitch-over maneuvers.
88D	7-16-61	14	7-19-61	None	9-13-61	1254	Flight was successful. Capsule was placed in orbit; after one scheduled orbit capsule was recovered east of Bermuda. All objectives were satisfied.

* Returned to hangar for booster power package replacement.

SIGNIFICANT DATES DUR NG TESTING OF MIDAS VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
29D	10-10-59	14	1-18-60	None	2-26-60	304	MIDAS I Booster shot. Atlas portion of flight was successful.
45D	1-26-60	14	3-2-60	None	5-24-60	619	MIDAS II Booster shot. Atlas portion of flight completely successful.

SIGNIFICANT DATES DURING TESTING OF RANGER VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
11.D	5-27-61	12	5-29-61	None	8-23-61	5050	Atlas/Agena Booster portion of flight was successful. Agena spacecraft orbit was not satisfied due to a malfunction in upper stage operation.

SIGNIFICANT DATES DURING TESTING OF ATLAS/ABLE LUNAR PROBES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
9C	4-4-59	12	4-15-59 #8-17-59	9-24-59		2944	Destroyed by fire and explosion following premature cutoff during flight readiness firing.
20D	9-10-59	14	10-19-59	None	11-26-59	4122	Atlas/Able IV Lunar Probe. Atlas portion of flight was successful. Portions of Able failed at 47 seconds.
80D	8-13-60	12	9-2-60	None	9-25-60	2801	Atlas/Able V Lunar Probe. Atlas portion of flight was successful. Second stage engine operation unsatisfactory.
91D	10-15-60	12	11-17-60	None	12-15-60	4508	Unsuccessful. Flight was terminated after 74.5 seconds when the vehicle destroyed itself.

Erected twice due to cancellation of test and subsequent return to hangar for storage.